Space Weather Technical Forecast

Issued on Friday 14 March 2025 at 13:26 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Isolated M-class flares likely. Chance G1/Minor Storms day 3-4 (16-17 Mar)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with peak flare C7.9 at 13/1935 UTC, from the combination flare from over the southeast limb, and AR4019 in the north-centre disc. This remains the most complex region on the disc, but has seen its weak delta spots fading, with only limited activity. AR4028 has been redefined in the southeast, with a new region now following, however this remains the next most notable region with some apparent growth of trailer and intermediate spots as this moves into view. Slowly increasing penumbral extent was also evident in AR4025 and AR4022 in the northeast however these remain relatively simple. The other regions remain small, simple and either stable or in decline.

No Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: Ongoing connection to CH22/- was observed. Solar winds, as measured by ACE at L1, erratically rose from around 480 km/s to 580 km/s. Density was below average. Interplanetary Magnetic Field strength, Bt, was Weak, below 8nT with north-south component, Bz, varying weakly between -8 and +8nT. However, an impulse evident on the GOES magnetometers around 14/0100 UTC, likely indicated the occurrence of a geomagnetic substorm, with a G2/Moderate Storm reported 14/0000-0300 UTC. (by Potsdam). Otherwise geomagnetic activity was Active (Kp 4) to G1/Minor Storm (Kp 5) at first, then eased to Quiet to Unsettled from 14/0300 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at Background. High energy electron flux (greater than 2 MeV) was High at first, then eased to be mainly Moderate to Background at times overnight, before rising to High by 14/1200 UTC. The 24-hour fluence remained below the Active threshold (1e8 integrated pfu), recording 3.61e7 integrated pfu at 14/0000 UTC, but with a rising trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity with isolated M-class flares likely.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Ongoing fast wind from CH22/- is expected at first, but likely easing for a time day 2-3 (15-16 Mar), before a further

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enhancement from any connection to CH23/- days 3-4 (16-17 Mar), although this is low confidence. Mainly Quiet to Unsettled geomagnetic activity is now expected day 1-2 (14-15 Mar), however isolated Active intervals with a slight chance of further G1 Minor Storms remain possible. The further enhancement is then likely to give a spell of Active to G1 Minor storms later day 3 or day 4 (15-16 Mar).

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at background. High energy electron flux is expected to reach Moderate to High levels, with an increasing chance of the associated 24 hour fluence becoming Active (greater than 1e8 integrated pfu). Confidence lowers for day 4 (17 Mar), with flux likely to become suppressed by any further fast wind onset, from CH23/-.

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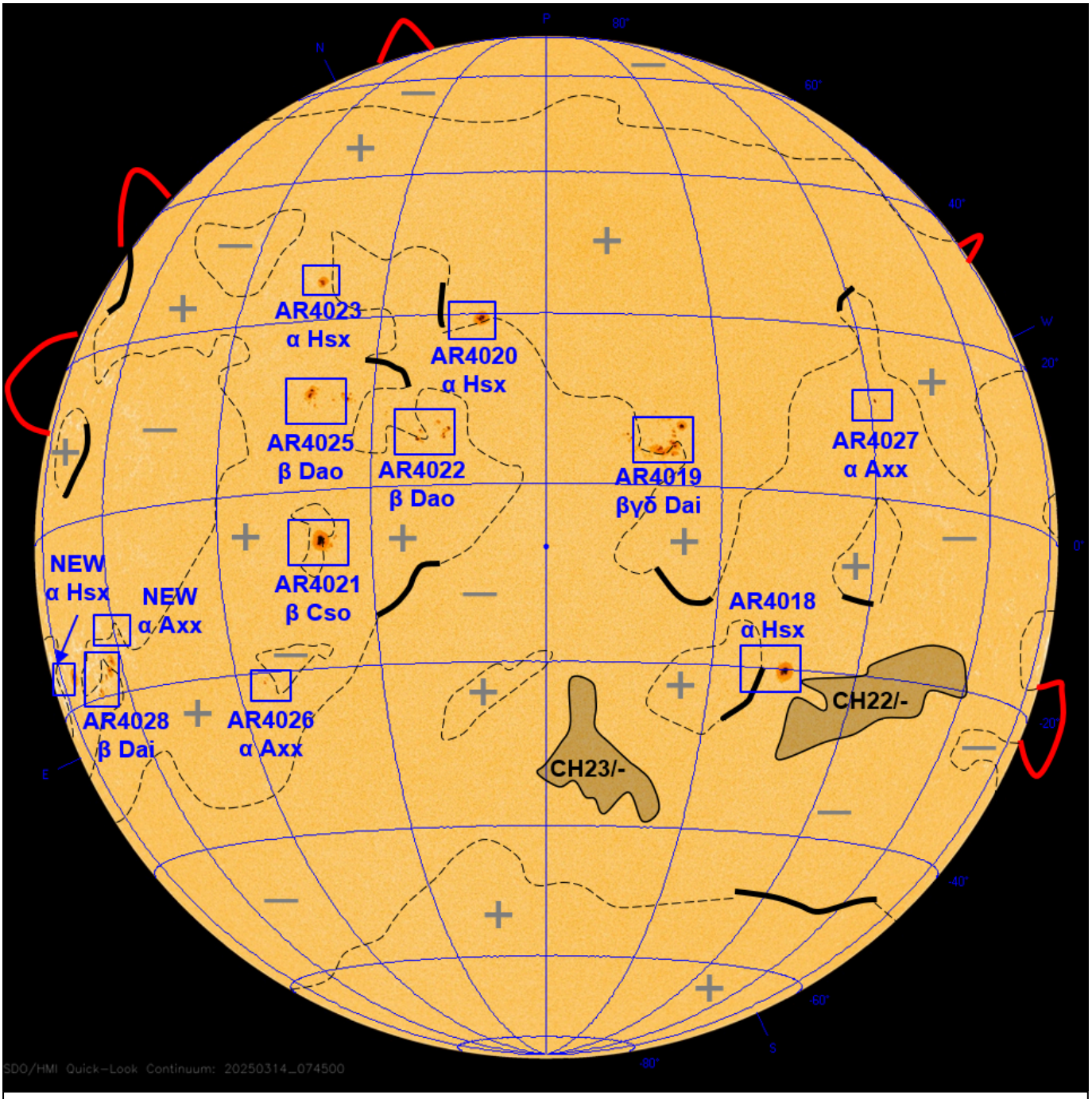
Figure 1: MOSWOC Solar Synoptic Map 14/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no Earth-directed CMEs.

Solar winds are currently Elevated due to the fast wind of CH22/- with speeds around 500-600km/s. Recent geomagnetic activity has largely eased, with mainly Quiet to Unsettled activity expected, however given the overnight substorm enhancement early on 14 Mar, and the recent activity levels, further Active intervals, with a slight chance of G1 Minor Storms, remain possible on day 1-2 (14-15 Mar). Conditions are expected to very gradually ease days 1-3 (14-16 Mar) before the next solar wind enhancement probably occurs from CH23/-, with solar winds rising again to elevated levels (500-600 km/s).

However it is worth nothing that CH23/- and CH22/- were a single feature until the development of AR4018 and its nearby flux emergence, which potentially obscure any connection that these features may still have. Due to this, it is possible that a more continuous spell of fast winds may occur throughout the period, which would reduce the potential geomagnetic activity on day 3-4 (16-17 Mar), due to the lack of any CIR region. This is supported both MOSWOC Enlil and also 27-day persistence adding to the potential uncertainty.

Due to this, confidence is lower than would typically be expected for the onset of geomagnetic activity from a negative coronal hole at this time of year, especially given recent enhancements. However it remains likely that a further spell of Unsettled to Active conditions, with isolated G1 Minor Storm intervals, will be observed late day 3 and into day 4 (15-16 Mar)

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	80	10	30	50
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: L1 Solar Winds (ACE). Shows ongoing fast wind and variable solar winds.

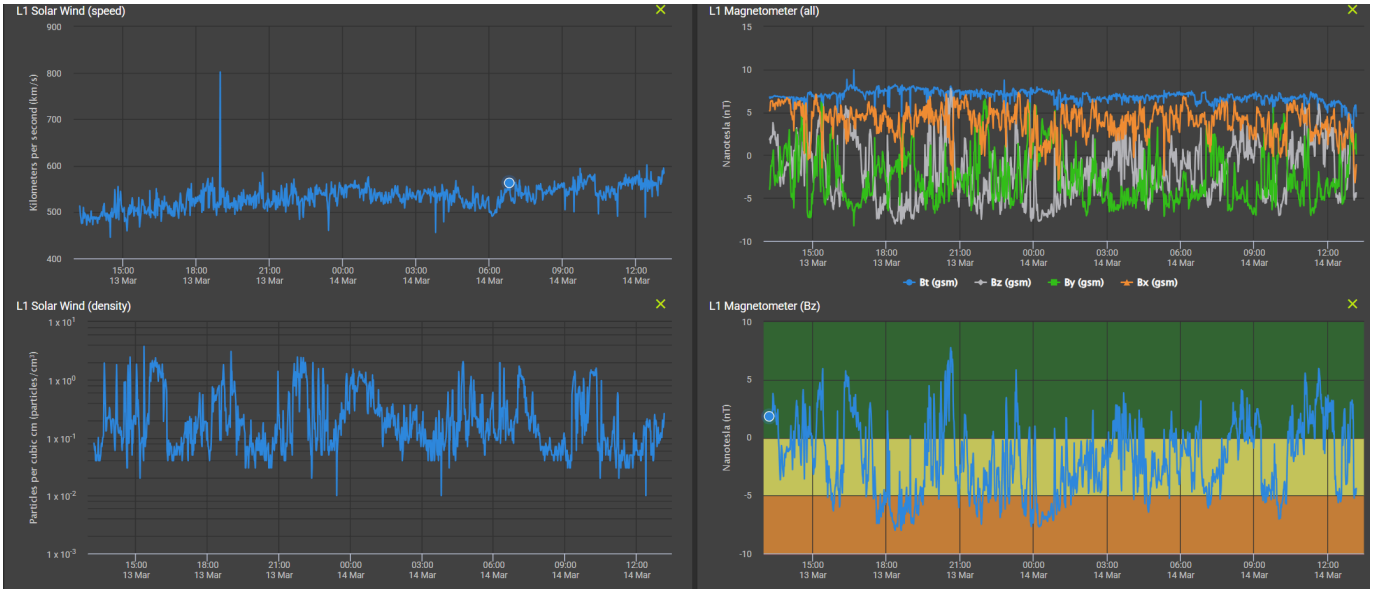
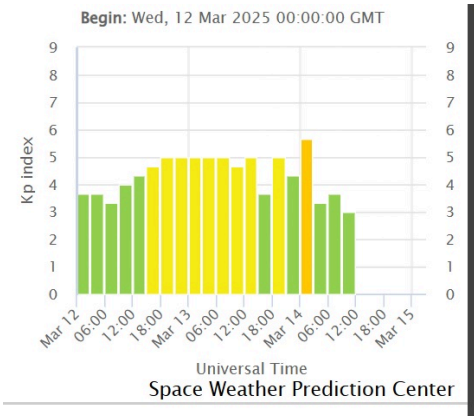
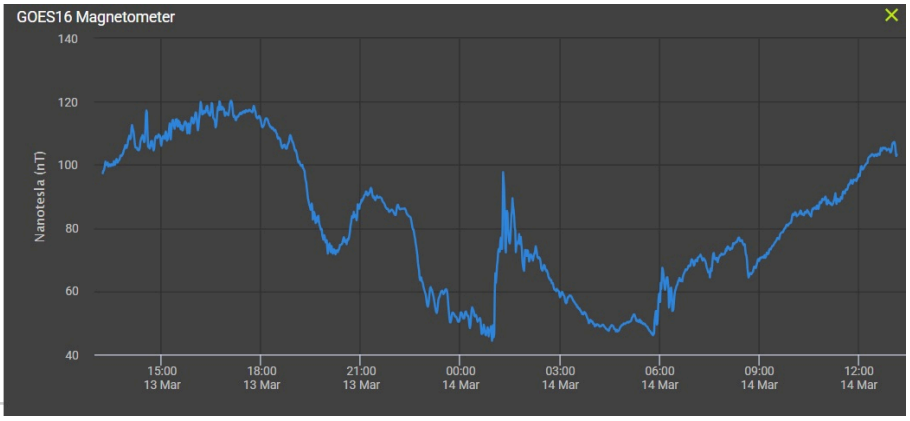


Figure 3: SWPC Geomagnetic activity (left) and GOES-16 Magnetometer. Sudden impulse around 14/0100 UTC despite lack of shocks at L1 suggest substorm effect with subsequent G2 observed.





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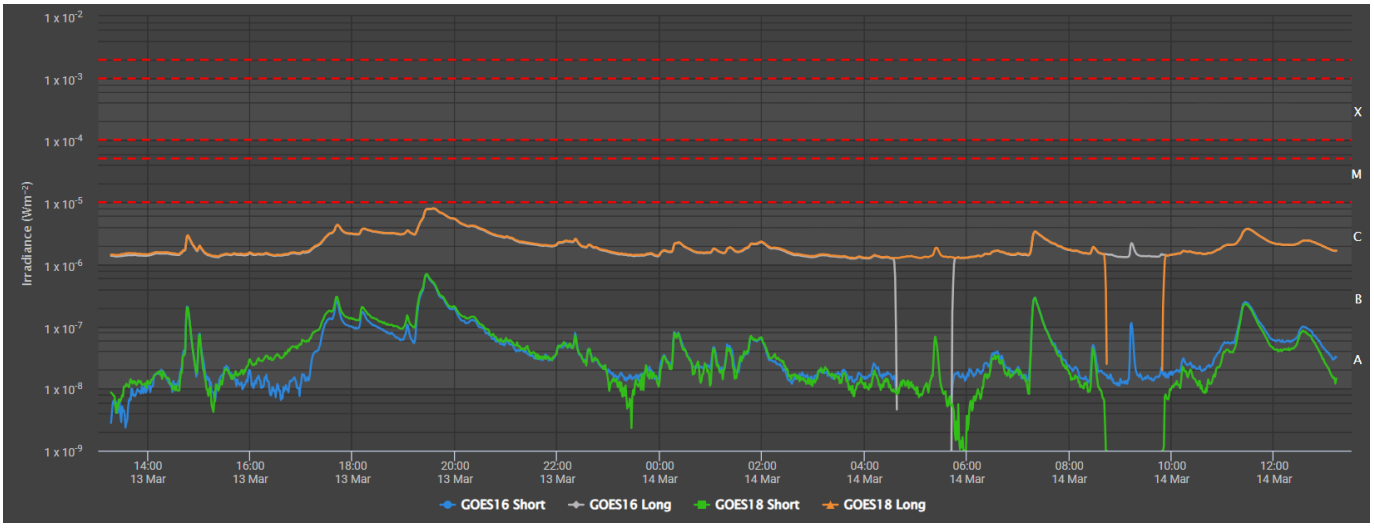
Radio Blackouts - X-Ray Flares

Low to Moderate activity is expected with a likelihood of isolated M-class flares and slight chance of X-class flares.

There are twelve regions on the disc, however the majority of these are small and simple. AR4019 just west of the north-centre disc, has been the most complex on the disc due to the delta spot on its southern periphery. However this region has been becoming more ragged in appearance, with the delta spot beginning to fade despite the lack of flares. This suggests a likely weakening trend, however isolated M-class flares remain possible as this occurs. AR4028, in the southeast, is perhaps the next most notable. This has recently been redefined, with the previous trailer now considered a new spot closer to the southeast limb, while some apparent growth is occurring within this newly defined regions. There has also bee some slight growth in a couple of the regions in the northeast disc, including AR4022 and AR4025, however these remain relatively simple in structure. Conversely AR4021 has seen its small delta spot decay and fracture from its main spot, simplifying the structure of this region. There are also some signs of a couple of further regions moving onto the southeast and northeast limbs, and these also add to the likelihood of an isolated M-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	60	60	60	60
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 4: GOES-16/18 X-ray Irradiance



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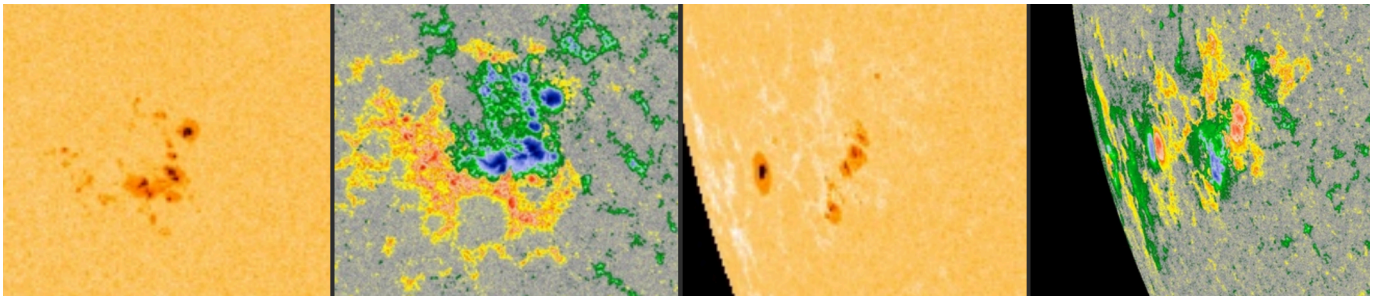
Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux is expected to remain at background, with only a slight chance of enhancement given any notable flares from the regions currently on the Earth-facing disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: AR4019 (left), AR4028 and NEW (right) SDO Intensitygram and Magnetogram



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High Energy Electrons (≥ 2MeV)

Despite ongoing fast wind from CH22/- some outward expansion of the Van Allen belts has been occurring with periods of High flux observed by GOES-16. These periods are likely to continue, perhaps becoming persistent from later day 1 (14), but with some potential for further periods of dropout associated with any geomagnetic activity that occurs. This is most likely with any enhancement that occurs from the onset of the fast winds, and any associated CIR region, of CH23/- later day 3 or day 4 (16-17 Mar)

Overall the fluence is expected to see a rising trend, likely reaching Active (1e8 integrated pfu) by the end of day 1 or early day 2 (14-15 Mar), and persisting into day 3 (16 Mar). This is supported by the 27 day persistence, with MOSWOC REFM also showing a rising trend. Confidence then decreases day 4 (17 Mar) due to the uncertainty regarding the next HSS arrival.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	40	70	70	30
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

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Figure 6: GOES-16 >2MeV Electron flux and associated Fluence with REFM and Persistence.

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